Bank Borrowing and Corporate Risk Management

Aziz A. Lookman

Tepper School of Business

Carnegie Mellon University

Pittsburgh, PA 15213

Email: aziz.lookman@cmu.edu

November 29, 2004

I thank my dissertation chair, Duane Seppi, for being a constant source of guidance, support and encouragement throughout my doctoral study, and members of my committee, Michael Gallmeyer and Richard Green for their counsel. I thank David Haushalter for being a great colleague, serving as a thoughtful sounding board for various research ideas. Comments from Norman Schuerhoff and Wenying Jiangli have helped to improve the paper. The most recent version of the paper is available at: `http://www.andrew.cmu.edu/user/al3v`. Comments most welcome.

Bank Borrowing and Corporate Risk Management

Abstract

Corporate risk management theory posits a firm hedges to improve the terms at which it can borrow. For the debt contract to reflect the lower default risk of the firm if it hedges, bond holders must be able to enforce the firm's hedging policy. However, only agents that specialize in lending, such as banks, have the expertise and necessary economic incentives to conducting such monitoring. This paper empirically examines whether a firm's hedging policy depends on who its creditors are using a sample of oil and gas producing firms that hedge commodity price risk. Amongst firms with high total levels of debt, we find that hedging is positively associated with bank debt but negatively associated with non-bank debt.

Keywords: hedging, leverage, bank debt

JEL Classification Codes: G21, G32

1 Introduction

Corporate risk management theory argues that debt financing provides a firm with incentives to hedge.[1] Hedging reduces a firm's cash flow volatility, which in turn decreases its likelihood of bankruptcy, and therefore its borrowing costs. Although several authors document a positive association between debt and hedging, the extant literature has not examined whether the nature of debt ownership is an important determinant of a firm's hedging policy. This omission is surprising, given the considerable effort expended on examining whether a firm's hedging policy depends on the nature of its equity ownership.[2] This paper takes a first step towards closing this gap by examining whether the use of bank versus non-bank debt affects a firm's hedging decision. We are motivated to differentiate debt in this manner because of the asset substitution problem created by the hedging decision, and the ability of a bank to resolve this problem through its monitoring efforts.

Although a firm has strong incentives to state it will hedge *ex-ante* its *ex-poste* incentives to implement the promised hedging policy are unclear. If, as Jensen and Meckling (1976) argue, equity holders have a convex claim on a firm's assets, once the debt is in place, they now have incentives to increase, rather than decrease, firm risk.[3] These agency conflicts will be particularly pronounced for firms with high levels of debt. Since banks specialize in the business of lending, they have the ability and the necessary economic incentives to monitor and enforce the firm's financial and operating policies stipulated

[1]See, for example, Smith and Stulz (1985), Leland (1998), Ross (1997)
[2]The extant literature is reviewed in Section 2.
[3]The timing is with respect to issuance of the debt.

in the debt covenants. In this paper, we empirically examine whether the agency conflict between equity and debt holders coupled with a bank's superior monitoring ability results in different hedging policies for firms that borrow from banks versus non-banks. We posit that the relationship between leverage and hedging is positive only for bank debt.

We conduct our analysis using a sample of oil and gas producing firms that hedge commodity price risk. For these firms, commodity price is a significant risk, and hedging this risk can reduce the likelihood of bankruptcy, particularly for highly levered firms. While restricting ourselves to a single industry does come at the cost of being able to include only a relatively small number of firms in our data set, we eliminate the substantial variation in financial policies driven by cross-industry effects.

We find considerable evidence in support of our hypothesis that only bank debt – as opposed to total debt – is positively associated with hedging. First, we find that the level of bank debt is positively associated with the level of hedging. In contrast, for non-bank debt, we find that the hedging-leverage relation is strongly non-monotone and hump-shaped. Second, we examine whether the relationship could run in the reverse direction by examining whether hedging-causes-bank-debt, and find that it does not. Taken together, these findings suggest that banks are able to enforce a firm's stated hedging policy, particularly when hedging can measurably reduce bankruptcy risk. Finally, for a sub-set of firms, we examine in detail the debt covenants for the bank and non-bank debts and find explicit hedging covenants for some of the bank debt contracts, but do not find any such covenants in any of the non-bank debt contracts.

Our paper contributes to the literature by demonstrating the importance of the nature of debt ownership on a firm's hedging policies. The extant literature has extensively examined the role of the *level* of debt and the nature of *equity* ownership on a firm's hedging policy. To our knowledge, this is the first paper to document the role of *debt* ownership. This paper also contributes to the financial intermediation literature by demonstrating how banks are able to resolve a particular asset substitution problem through their superior monitoring efforts.

The rest of the paper is organized as follows: Section 2 reviews the literature. Section 3 discusses the hypothesis, Section 4 describes the data set. The results are presented in Section 5, and the associated robustness tests in Section 6. The economic significance of bank versus non-bank debt on hedging policy is discussed in Section 8. Finally, Section 9 concludes.

2 Literature Review

Risk management theory motivates hedging as a means for a firm to reduce the deadweight costs caused by a range of financing frictions, such as: tax deductibility of interest payments, financial distress and bankruptcy costs, imperfect contracting and asymmetric information. This paper focuses on debt-related motivations.

As Stulz (1996), Ross (1997) and Leland (1998) argue, hedging increases debt capacity by reducing the likelihood of bankruptcy. Managers of a firm might want to increase debt capacity for several reasons. If a firm is profitable, the associated increase in interest payments reduces tax liabilities. Or, if debt financing is cheaper than equity financing, as posited by the pecking order theory of capital structure, the extra leverage reduces the overall cost of capital. Alternately, in the spirit of Tufano (1998), managers might hedge to increase debt capacity for personal gain. For instance, managers might issue debt to fund their pet projects. Since suppliers of debt financing are primarily concerned about bankruptcy risk rather than the upside potential of the investment opportunity, managers presumably find it easier to raise debt versus equity to fund such projects. Regardless of whether hedging is used to increase debt capacity to maximize shareholder or manager value, theory predicts a positive association between hedging and leverage.

Several recent papers empirically examine the hedging - leverage relationship. For example, Haushalter (2000) finds that higher leverage is associated with higher levels of hedging. Graham and Rogers (2002) conclude that the relationship is two-way: hedging increases leverage and leverage increases hedging. However, other papers find conflicting evidence. For example, in an international sample of firms, Bartram et al. (2003) find leverage explains the hedging decision only in certain countries, while Tufano (1996) and Geczy et al. (1997) find that leverage is not a significant determinant of either the level or the likelihood of the hedging decision.

Moreover, it is not clear if the hedging-increases-leverage argument is dynamically consistent. A firm has strong incentives to claim to potential lenders that it will hedge. But, lenders recognize that with the debt in place, the risk management incentives of equity and debt holders are not necessarily aligned.

If, as argued by Jensen and Meckling (1976), equity has a convex claim on a firm's assets, shareholders will want to speculate rather than hedge. Therefore, it is not completely clear how leverage induces firms to hedge. Purnanandam (2003) offers a solution to the *ex-ante/ex-poste* hedging incentive problem for moderately levered firms. For these firms, he motivates *ex-poste* hedging by arguing that equity is a *concave* claim on the firm's assets. Low cash flow realizations for such a firm results in the firm being in a state of financial distress. In this state, equity holders bear the deadweight costs of not being able to efficiently run the firm. They cannot pass on these deadweight costs to the debt holders because the firm is still too valuable to make default worthwhile.[4] However, at high levels of leverage, states of financial distress and of bankruptcy coincide, and Purnanandam predicts that highly levered firms will not hedge. Consistent with his theory, he finds, on average, a humped-shaped relationship between leverage and hedging. Our work complements that of Purnanandam (2003), by focusing on the differences in hedging behavior for firms with different sources of debt. Further, unlike Graham and Rogers (2002) or Purnanandam (2003), we exploit the panel data nature of our sample to examine how changes in the different types of debt lead to changes in a firm's hedging policy.

We contribute to two areas in the financial economics literature. First, we contribute to the risk management literature by documenting the importance of the type of a firm's lenders on its hedging policy. To our knowledge, this

[4]The deadweight costs considered include direct and indirect costs, such as: forgone investment opportunities, restrictions imposed on how the firm is managed by the lenders, and the time spent by managers on negotiations with lenders.

is the first paper to examine whether the *source* of debt affects a firm's hedging policy, and complements the extant literature which examines how the source of *equity* affects a firm's hedging policy.[5] Second, we contribute to the literature on financial intermediation. Amongst the motivations considered for bank financing is the monitoring role played by banks to resolve the asset substitution problem.[6] Examining a firm's risk management policy provides a clean natural laboratory to examine whether bank monitoring does indeed solve this problem, and our results suggest that it does. Another motivation for bank financing is the relative efficiency of reorganization and liquidation in the event of bankruptcy. Our results suggest that by ensuring firms hedge – particularly the highly levered firms – banks can also reduce the likelihood of bankruptcy in the first instance.[7]

3 Hypothesis Development

Given the moral hazard problem associated with *ex-poste* hedging and the monitoring role played by banks, we predict:

H1: The hedging - leverage relationship will be monotone only for bank debt.

[5]For example, Knopf et al. (2000) and Graham and Rogers (2002) examine whether a firm's hedging policy reflects a manager's risk preferences. They conclude that hedging is positively associated with the delta of the manager's portfolio with respect to the company's stock and negatively associated with its vega. However, Haushalter (2000) finds contrary evidence, with hedging negatively related to insider ownership.

[6]Kang et al. (2000) investigate whether bank monitoring leads to better investment policy by examining takeover decisions by firms with different types of banking relationships.

[7]See Berlin and Mester (1992), Berlin and Loeys (1988), Chemmanur and Fulghieri (1994), for example. For summaries of the theoretical literature on the choice of lender as well as empirical evidence of the various models, see Cantillo and Wright (2000) and Johnson (1997).

We test this hypothesis by estimating a model for the hedging decision using various measures of bank debt and non-bank debt as explanatory variables. We also include additional controls to account for non-debt motivations for hedging. The construction of the dependent and explanatory variables is described below.

3.1 Dependent Variable - Extent of Commodity Price Risk Hedged

We conduct our analysis using a sample of oil and gas producing firms that hedge commodity price risk.[8] The proxy for hedging is the net fraction of next year's production that is protected against a drop in commodity prices either through the use of derivatives, such as: forward contracts, puts, or collars, fixed-price delivery agreements, or advance sales.[9] The current year's production is used as an estimate for next year's production.

3.2 Debt-Related Explanatory Variables

We use long-term debt, normalized by total assets, to proxy for leverage. To differentiate between hedging incentives of moderately versus highly levered firms, we also include a measure for high leverage. The main results are presented using a high leverage dummy that equals unity if the leverage ratio is greater than the 90th percentile value. As a robustness check, several alternate

[8]The sample is described later in Section 4.

[9]Fixed-price delivery contracts are effectively forward contracts, and advance sales contracts are equivalent to a standard debt contract bundled with a forward contract.

proxies are also employed.[10] To proxy for the source of debt, we use the ratio of long-term bank debt to total long-term debt. For firm-years with zero debt, this ratio is set equal to zero. To examine how bank debt affects hedging policy at moderate and high leverage, we include interaction terms of the bank-to-total-debt ratio with the proxies for leverage and high leverage as additional explanatory variables.

3.3 Control Variables

Risk management theory posits several non-debt related motivations for hedging, such as underinvestment costs and liquidity considerations (Froot et al. (1993), Smith and Stulz (1985)), and managerial risk aversion (Smith and Stulz (1985)).[11] In this section, we describe the control variables used.

Scale: It is unclear what should be the relationship between size and hedging. Larger firms should have a greater incentive to hedge because of economies of scale. However, given that larger firms are often more financially solvent, their benefits from hedging are probably lower. We use the log of total assets as a proxy for firm size.

Underinvestment Costs: Froot et al. (1993) posit that firms hedge to

[10] The robustness tests are discussed in greater detail in Section 6.

[11] We note but do not control for other motives such as information asymmetry between managers and outsiders of the firm (DeMarzo and Duffie (1991), DeMarzo and Duffie (1995) and Breeden and Viswanathan (1998)). These game-theoretic models motivate hedging as a means for firms to alter how informative realized earnings are about the manager's or firm's quality. In our sample, the effect of fluctuations in commodity prices, the risk being hedged, can be easily extracted from the firm's 'core' earnings. Hence, earnings management motivations are unlikely to motivate hedging in our sample. Smith and Stulz (1985) posit that hedging is motivated by the convexity of the income tax code, so that expected taxes decrease if a firm hedges. Since Graham and Rogers (2002) find no evidence of firms hedging in response to tax-convexity motivations, we do not include any controls for tax convexity in our regressions.

reduce underinvestment costs. Since these costs depend on a firm's growth options, we include different controls for growth options in our model specification. We use the ratio of capital expenses normalized by total assets as our proxy for growth options. As a robustness check, we also use the ratio of undeveloped to total reserves as an alternate proxy.

Liquidity Considerations: Deadweight costs that can be eliminated by hedging will be lower for firms that have liquid assets or access to financial markets. Therefore, such firms are expected to hedge less. We use a firm's cash holdings, normalized by total assets, as a proxy for liquid assets. To control for financing constraints, we use a dummy that equals unity if the firm pays dividends on its common stock. As a robustness check, we use the Kaplan-Zingales index as an alternate proxy.

Managerial Motivations: Smith and Stulz (1985), amongst others, argue that a firm's hedging policy is dictated by managerial portfolio considerations. Managers with large stock positions in their own firm hedge to reduce the risk of their undiversified portfolio, whereas managers with large option holdings do not, since their portfolio is long volatility. Tufano (1996), Knopf et al. (2000) and Graham and Rogers (2002) find evidence consistent with this argument. However, Haushalter (2000) finds some evidence to the contrary. Further, it is unclear whether typical hedge positions are large enough to have a significant impact on the volatility of a firm's stock price.[12] We use the fraction of common shares held by insiders to control for managerial hedging

[12]Firms typically hedge the fluctuations in the next period's earnings or cash flows. Since typical P/E ratios are on the order of 20, such hedges will only have a marginal impact on stock price volatility.

motives.

4 Sample Formation and Data

The sample consists of firms identified as oil and gas producers in the 1999 and 2000 annual COMPUSTAT file, based on their 4-digit SIC code of 1311. To facilitate data collection, we limit our sample to firms that have their 10-Ks available electronically at the SEC EDGAR database. After an initial screening, we further limit the sample to firms that have total assets greater than $ 20 million and are incorporated in the US, Canada or the Cayman Islands; data required for our analysis is typically not reported for smaller firms and those incorporated elsewhere. Finally, to ensure that commodity price risk is a uniformly large risk for all firms in our sample, we restrict our sample to only include firm-years where revenues from oil and gas production constitute at least 80% of the total.[13] Our final sample consists of 146 firm-years, and is comparable in size to samples used for other single-industry studies on hedging policy. For example, Carter et al. (2004) examine hedging practices in the airline industry using a sample of 154 observations, and the results of Tufano (1996) on hedging practices in the gold industry are based on a sample of 108 observations. We then manually read through the annual reports to collect information on hedge positions and source of debt financing for the years 1999 and 2000. Most firms in our sample hedge use vanilla derivatives, such as forwards or collars. Some also hedge using fixed price

[13]The 80% cutoff is chosen to be consistent with the definition used in Lookman (2004) for commodity price to be a large, primary risk for the firm. We repeated our analysis using 70% and 90% as the cutoff. Our main findings are unaltered.

sales contracts or commodity loans.[14] We also collect information on select operating characteristics, such as reserves and production information and firm ownership (from the SEC Def-14A filings, the Thomson Financial database, and proxy statements). The balance of the data required for the analysis is from the annual COMPUSTAT database.

The summary statistics for the data is shown in Table 1. There is considerable variation in both, hedging policy and source of debt. Both variables vary between 0 and 100%, suggesting that this is a useful dataset to explore the dependence of hedging on the source of debt. Less than 10% of the firm-years have no debt. The hedging intensity in our sample is comparable to that found in other extractive industries. For example, Adam (2002) reports that the median fraction of production hedged in the gold mining firms is 0.38 versus 0.25 in our sample. The fraction of debt from banks is comparable to that reported by Cantillo and Wright (2000) in a broad cross-industry sample (mean private-to-total-debt ratio of 0.77 vs a bank-to-total-debt ratio of 0.50 for our sample), suggesting that the intensity of the use of bank debt in the E&P industry is representative of the overall use of bank debt.

5 Results

Our central hypothesis is that the asset substitution problem associated with hedging, coupled with the monitoring function of a bank will result in different hedging policies when a firm's lender is a bank versus a non-bank. Since the

[14] Commodity loans are debt contracts specifying repayment in the form of oil or gas. They are equivalent to a standard debt contract coupled with a forward contract.

agency conflict will be particularly acute for highly levered firms, we first focus on highly levered firms and estimate a model of the form:

$$\begin{aligned} hedging \; = & \beta_L * L \; + \beta_{HL} * HL + \\ & \beta_{HLR} * HL * R + \\ & \beta_X * X + \varepsilon \end{aligned} \tag{1}$$

where, L is the proxy for leverage, HL the proxy for high leverage, R the ratio of bank to total debt, and X is a set of controls that includes the bank debt ratio.[15]

Table 2 presents results of estimating a pooled Tobit model specified by Equation 1. The regression coefficients are reported as marginal effects.[16] Model 1 is a restricted version of the full model, with the interaction term omitted. This specification is equivalent to that of Purnanandam (2003). Consistent with his results, the coefficient for the leverage variable is positive and significant, whereas for the high leverage term is negative and significant. This finding suggests that along the leverage dimension, the hedging policy in our single-industry sample is representative of cross-industry practice.

Model 2 is the full model and includes the high leverage - bank debt ratio interaction term. This term takes on high values when the firm is highly levered *and* a large fraction of its debt is from banks. While β_{HL} remains significantly

[15] Throughout this paper, X includes a vector of constants so that the constant term in the regression is included in the $\beta_X * X$ term.

[16] The parameter estimates from a Tobit regression represent the marginal effect of each regressor on the *unobserved* dependent variable, Y_i^*. However, we are more interested in the marginal effect on the *observed* dependent variable, Yi. We calculate the marginal effect of a change in the kth regressor is calculated as $\Phi(z)\beta_k$, where $\Phi(z)$ is the normal CDF, evaluated at $z = \beta' \overline{X} / \sigma$, where $\overline{X}$ is the means of the independent variables and β_k is the vector of coefficients. See Maddala (1983) for additional details.

negative, β_{HLR} is significantly *positive*. This finding clearly demonstrates that the source of debt has a significant effect on a firm's hedging policy, particularly for highly levered firms. For such firms, the downside risk of commodity price volatility is borne primarily by the debt holders and therefore have strong disincentives to hedge. As the results show, these firms only hedge because of the strong enforcement action of the bank.

With the interaction term included, β_{HL} now measures hedging incentives of a firm that is highly levered and has a *small* fraction of its debt held by banks. The magnitude of β_{HL} now doubles from -0.203 to -0.410. Also, the explanatory power of the model significantly improves. The pseudo-R^2 increases from 0.217 to 0.258, an increase of 16%.

Since earlier empirical work assumes that the relationship between hedging and leverage is linear, it is interesting to examine whether the hedging-leverage is linear – in addition to being monotone – for bank debt. We test for linearity by re-estimating Model 2 after imposing the restriction $\beta_{HL} + \beta_{HLR} = 0$. Rejection of the constrained model implies that the relationship is non-linear. We find that the constrained model is *not* rejected, with the p-value associated with this restriction being 0.42. This finding suggests that the hedging - leverage relationship is well described by a linear model for bank debt. In contrast, the relationship is non-monotone and significantly non-linear for non-bank debt. Stated differently, the non-monotonicity in the hedging-leverage relationship only arises in firms that use non-bank debt.

6 Robustness Tests

6.1 Alternate Proxies for High Leverage

The analysis presented in Section 5 focuses on highly levered firms. To demonstrate that the results are not critically dependent on the proxy used for high leverage, we re-estimate the hedging model using several different proxies. These results are shown in Table 3. Panel A summarizes the earlier results using the high debt dummy as the proxy for high leverage. Next, we use continuous variable to proxy for high leverage. Panel B uses a 'hockey stick' function defined as: $max[0, D/A - X]$, where D/A is the leverage proxy and X is its 90th percentile value. Following Purnanandam (2003), we also use the squared value of debt-to-assets, as shown in Panel C. Our main results are unaltered.

6.2 Endogeneity of Explanatory Variables

Since leverage and source of debt are also decision variables, we examine whether the endogeniety of these variables is significant by performing a Hausman test.[17] We first estimate models for leverage, the high leverage dummy and the bank-to-total-debt ratio. Next, we compute the residuals from these models and include them in the Tobit regression. A statistically insignificant coefficient on these residual terms is interpreted to mean that endogeniety is not a significant concern. The coefficients on none of the residual terms is significantly different from zero and the null hypothesis that all of the coefficients

[17]See Davidson and MacKinnon (1993), page 541 for details.

are zero cannot be rejected. Therefore, we conclude that our results are robust to concerns about endogeniety. The results of the Hausman test are provided in Appendix A for the interested reader.

6.3 Change Regressions

The results shown in Table 2 depend on both, the cross-sectional and time-series variation in hedging policy and leverage. To complement these results, we now perform a change regression, so that the coefficients are estimated by the within-firm time series variation in the explanatory variables. We estimate a model of the form:

$$\Delta H = \beta_L * \Delta L + \beta_{HL} * \Delta HL + \beta_{HLR} * \Delta HL * R + \beta_{X'} * \Delta X' + \varepsilon \qquad (2)$$

where, for any variable Z, ΔZ_i is defined as $Z_{i,t} - Z_{i,t-1}$, H is the fraction of production hedged, L is the leverage variable, with the debt-to-asset ratio used as its proxy, HL is the high leverage proxy, R is the bank debt ratio, and X' is the set of control variables used. Since the sample size for the change regression is considerably smaller than for the level regression, we drop control variables that are found to be not significant in the level regression to improve the statistical power of our estimation. The results are shown in Table 4. As seen, the high leverage proxy continues to be negative and significant, and its interaction with the bank debt ratio continues to be positive and significant. The null hypothesis that $\beta_{HL} = \beta_{HLR}$ is rejected at the 5% significance level (p-value =0.028). As compared to the level regression, the statistical significance of several of the variables is lower in the change regression because of the smaller sample size.

6.4 Reverse Causality

The results of the change and level regressions suggest that bank debt causes hedging. One potential concern is that the causality could also run in the opposite direction. For instance, firms might choose to hedge as a means of signalling to banks that they are "good risks" and therefore worth lending to. If the causality runs in the opposite direction, hedging at time *t-1* should explain bank debt at time *t*. To investigate this issue, we estimate a model of the form:

$$B_t = \beta_1 * H_t + \beta_2 * H_{t-1} + \beta_3 * B_{t-1} + \beta_W * W_t + \varepsilon \tag{3}$$

where B_t is the contemporaneous bank debt, normalized by total assets, H_t and H_{t-1} are the contemporaneous and lagged fraction of production hedged, and W is a set of explanatory variables considered in the literature to explain a firm's level of bank debt. If the causality runs in the reverse direction, β_2 will be significant and positive. For the explanatory variables, we simply adopt a 'kitchen sink' approach and include all exogenous and instrumental variables used earlier for the Hausman test and were significant in explaining either the level or the source of debt. See Appendix A for further details. The estimation results are shown in Table 5. As seen, only the contemporaneous hedging variable is significant, whereas the lagged one is not. This finding suggests that reverse causality is not a concern.

We also estimated an analogous model for non-bank debt. In unreported results, we find that neither the contemporaneous nor lagged hedging variable is significant in explaining the level of non-bank debt. Taken together with the results for the effect of hedging on bank debt, these results suggest that firms hedge because banks force them to do so, rather than firms voluntarily hedging to attract additional debt financing from the public capital markets.

6.5 Alternate Econometric Specifications

We also examine whether the results are sensitive to the particular choice of proxies used for control variables. In unreported regressions, we re-estimate the model using two different proxies for growth options: capital expenses scaled by sales (instead of assets) and the ratio of undeveloped to total proven reserves. We also use the Kaplan-Zingales index (instead of the dividends dummy) as the proxy for financing constraints. We also included a negative book equity dummy as a control for financial distress. Our main findings are unaltered.

Since the extant literature documents that unrated firms and small firms have a greater reliance on bank financing, we also investigate whether our results are primarily driven by ratings or size effects. In unreported results, we estimate models of the form:

$$
\begin{aligned}
production\ hedged\ =&\beta_L * L\ + \beta_{HL} * HL\ + \beta_{HLR} * HL * R + \\
&\beta_{HL-unrated} * HL * I_{unrated} + \beta_{HL-size} * HL * SIZE + \\
&\beta_X * X + \varepsilon
\end{aligned}
\tag{4}
$$

where HL is the high leverage dummy, I_{rated} is a dummy variable that equals unity if the firm is unrated and $SIZE$ is the proxy used for firm size, namely, the log of the total assets of the firm. If the effect we document is primarily due to a ratings effect or size effect $\beta_{HL-unrated}$ or $\beta_{HL-size}$ should be significant and β_{HLR} should no longer be significant. The estimation results for a pooled Tobit model of this specification are shown in Table 6. As seen, β_{HLR} remains significantly positive, while both, $\beta_{HL-unrated}$ and $\beta_{HL-size}$ are statistically insignificant, suggesting that our results are not driven simply by a debt rating or size effects. Note that $HL{*}R$, $HL{*}I_{unrated}$, $HL{*}SIZE$, and HL and highly correlated. To work around the usual problems associated with correlated regressors, we project the interaction terms on HL and then use the residual for estimating the hedging model.

6.6 Internal Governance Mechanisms

We now briefly examine the effect that alternate governance mechanisms have on the asset substitution problem. Several recent papers document that corporate governance features of a firm significantly affect a firm's borrowing costs (see Ashbaugh et al., 2004; Bhojraj and Sengupta, 2004; Chava et al., 2004;

Cremers et al., 2004). We explore whether a firm's hedging policy might be the mechanism through which these governance effects affect borrowing costs. We focus on insider ownership.

For a diversified shareholder, equity in a highly levered firm is a convex claim on the firm's assets. However, for a manager with a large stake in the firm, this might not be the case since a significant portion of her wealth might be in the firm's equity. Hence, hedging policies in highly levered firms with and without insider ownership might be different. To investigate this possibility, we re-estimate the hedging model after interacting the fraction of insider ownership with the high leverage variable as an explanatory variable. That is, we estimate a model of the form:

$$\begin{aligned} hedging\ =& \beta_L * L\ + \beta_{HL} * HL + \\ & \beta_{HLF} * HL * F + \\ & \beta_X * X + \varepsilon \end{aligned} \tag{5}$$

where, L is the proxy for leverage, HL the proxy for high leverage, F the fraction of common shares owned by insiders, and X is a set of controls used previously, which includes the bank debt ratio as well as F. The results of estimating this model using the high leverage dummy as the proxy for high leverage are shown in Table 7 and are labelled as Model 1. As seen, insider ownership also seems to be effective in mitigating the asset substitution problem associated with hedging. We now examine whether insider ownership is a complement or substitute for bank supervision by estimating a model that also includes the $HL*R$ term, which is the interaction of the high leverage variable with the bank debt ratio. Results for estimating this model are also shown in Table 7 and are labelled Model 2. As seen, the effects seem to complement each other. These results should be interpreted with caution, however. The $HL * F$ term is only marginally significant in Model 1, and is no longer significant in a change regression analogous to Equation 2 or when $(D/A)^2$ is used as the high leverage variable.

We also perform a similar analysis using institutional ownership instead. In unreported results, we find no significant differences between firms with high and low institutional ownership.

7 Descriptive Evidence

We complement our formal econometric analysis by providing some descriptive evidence. We identify observations that are in the top decile of bank or non-bank debt and search for any explicit hedging covenants. For expositional convenience, we refer to these observations as high bank debt and high non-bank debt groups, respectively. Amongst the high bank debt group, 25% of the bank loan contracts contain an explicit covenant about hedging. In contrast, none of the non-bank loans in the non-bank group contain a hedging covenant. This evidence further supports our conclusion that banks force firms to hedge, rather than firms choosing to hedge to attract bank financing. Non-bank contracts presumably do not contain hedging covenants because non-bank bondholders recognize that it is too costly for them to monitor a bank's hedging policy.

How do banks actually monitor a firm's hedging policy? One method used in practices is to bundle the loan and hedging contract. For example, Esenjay Corporation in its 2000 annual report states, "In February of 2000, in conjunction with its financing with Deutsche Bank, the Company established natural gas hedges with an affiliate of Deutsche Bank." With the hedging contract also held by the bank, it is relatively easy for the bank to ensure that the firm is in compliance with the hedging covenants of the loan contract.

8 Economic Significance of Bank versus Non-Bank Debt on Hedging Policy

To illustrate the economic significance of the source of debt on hedging policy, we plot the variation in hedge ratios implied by the various models in Figure 1. To facilitate comparison of our results with the extant literature, these plots are generated using the squared value of debt-to-assets as the proxy for high leverage, as used by Purnanandam (2003).

We first estimate a model of the fraction of production hedged without differentiating between bank and non-bank debt. The leverage coefficients of this model are reported in Panel C of Table 3. Using the slope estimates of this model, we plot the variation in hedging policy with leverage. This line is labelled *pooled* in Figure 1. The plot is generated by varying leverage while holding all other variables fixed, with the fitted value of the hedging variable set to zero at zero leverage. That is, the equation for the plotted line is:

$$\textit{production hedged} = \widehat{b_1} \times \frac{D}{A} + \widehat{b_2} \times (\frac{D}{A})^2$$

where $\widehat{b_1}$ and $\widehat{b_2}$ are the estimates of the slope coefficients from Model 1 and $\frac{D}{A}$ is the debt-to-asset ratio. Consistent with Purnanandam (2003), the relationship between hedging and leverage appears hump-shaped.

Next, we estimate the model specified by Equation 1 where we differentiate between bank and non-bank debt by including the interaction term of the bank debt ratio and the high leverage proxy as an additional explanatory variable. As discussed in Section 5, the hedging-leverage relationship is significantly non-linear only for non-bank debt. Accordingly, we model the hedging-bank debt relationship to be linear by imposing the constraint $\beta_{HL} = -\beta_{HLR}$. As discussed earlier, this restriction is non-binding and for this specification, its p-value is 0.838. Using the slope estimates from this model, we now plot the variation in hedging with each type of debt using the same procedure as used for generating the *pooled* plot. For the *bank debt* plot, the bank debt ratio, denoted by R in Equation 1, is set equal to unity. For the *non-bank debt* plot, it is set to zero. As with the *pooled* plot, we set the fitted value of the hedging variable to zero at zero leverage for both plots.

As seen from Figure 1, the relationship between hedging and leverage is markedly different for bank versus non-bank debt. For any given level of indebtedness, firms hedge a larger fraction of their exposure if they borrow from banks versus non-banks. The differences are particularly pronounced for highly levered firms. For example, at a debt-to-equity ratio of 0.8, firms that borrow entirely from banks hedge on average 50% of their next year's production, whereas firms with only non-bank debt hedge only 15% of their production.

9 Conclusion and Implications

Although the extant literature recognizes the importance of leverage as a determinant of a firm's hedging policy, the role of the nature of debt ownership has not been previously addressed. This paper begins to fill this gap by examining whether debt financing from banks versus non-banks affects a firm's hedging policy. Since banks have the ability and the necessary economic incentives to actively monitor their borrowers' financial policies, we posit that firms with bank loans will hedge a greater fraction of their exposure to commodity price risk. Consistent with our hypothesis, we find that hedging ratios for firms with bank financing is greater than for firms with non-bank financing, particularly for highly levered firms.

There are several important implications for these findings. First, these results imply that the relation between hedging and leverage is monotone only when a firm uses bank debt, but is humped-shaped for non-bank debt. With the exception of a few recent papers, virtually all of the extant literature assumes a linear relation between hedging and leverage. Our findings suggest that when a linear specification is imposed, leverage will appear to be significant or insignificant in explaining the hedging decision depending on whether the predominant source of debt was bank or non-bank debt. Second, our results suggest an alternate explanation for the systematic differences in hedging practices across countries. For example, Bodnar et al. (2002) find that 78% of German firms use derivatives, as compared with only 57% of US firms.[18]

[18] Other recent papers that examine hedging policies using international samples include Lel (2003), Bodnar et al. (2002), and Bartram et al. (2003).

Unlike the US, banks in Germany have historically been large claim holders in firms and are active in the firm's decision making process. Our results suggest that the prevalence of derivatives use in Germany might be because banks play an active role in the financing and operation of their borrowers.

This paper focuses on whether the nature of a firm's lenders affect its hedging policy. An interesting question for future research is to examine whether the nature of the debt contract itself affects the hedging decision. In future work, we plan to examine the role of features such as debt convertibility, seniority and secured status.

A Hausman Test for Endogeniety of Leverage and Source of Debt

We perform a Hausman test to examine whether endogeniety is an important consideration for our results. In the first stage, we regress the leverage and bank debt ratio on the set of exogenous controls used in the Tobit regressions shown in Table 2, and on a set of instruments. Based on the empirical work of Graham et al. (1998), Cantillo and Wright (2000), and Johnson (1997), we use a bond rating dummy, a proxy for the marginal rate and the fraction of undeveloped reserves (a measure of intangible assets) as instruments for leverage and bank debt ratio.[19] For the high leverage dummy, we use a high leverage dummy calculated off the predicted values from the leverage regression as the instrument. The results of the first stage are shown in Table A-1.

In the second stage, we include the residuals from the first-stage regression as additional controls. The second-stage Tobit estimations are shown in Table A-2. None of the coefficients on the residual terms is significant. Further, the null hypothesis that each of the coefficients is zero cannot be rejected. Comparing the log-likelihood scores reported in Tables A-2 and 2, the Likelihood Ratio test statistic equals 2.0 for Model 1 and 2.4 for Model 2. In contrast the critical $\chi^2(3)$ value at the 90% confidence level is 6.25. These results suggest that the bias in our estimates caused by endogeniety is not significant.

[19]Our preference would have been to use the simulated marginal tax rate developed by John Graham. However, this rate is only available for two-thirds of our observations. Accordingly, we use the deferred taxes, normalized by total assets, as the proxy for the marginal tax rate of the firm.

Table A - 1: First-Stage Model of Endogenous Variables

Table A-1 shows the results of the first-stage pooled OLS regressions for the potentially endogenous variables. *Pretax ROA* is the before-tax earnings before extraordinary items scaled by total assets. *Debt rating* is a dummy variable that equals unity if the firm's long-term debt is rated. *Deferred taxes* is deferred taxes normalized by total assets, and is used as a proxy for the marginal tax rate. *Undeveloped reserves* is the ratio of undeveloped proven to total proven reserves, and is used as a proxy for intangible assets. *Predicted high leverage dummy* equals unity if the predicted value of debt-to-assets from the first-stage regression is greater than its 90th percentile value and zero otherwise. All other variables are described in Tables 1 and 2.

Dependent Variables	Debt-to-assets		High leverage dummy		Bank-to-total-debt	
Explanatory Variables	β	p-value	β	p-value	β	p-value
Exogenous Variables						
Intercept	0.552	0.000	0.184	0.185	1.249	0.000
Log(total assets)	−0.033	0.072	−0.029	0.147	−0.043	0.143
Cash-to-assets	−0.961	0.001	−0.310	0.469	−2.290	0.000
Capital expenses to assets	−0.211	0.098	0.002	0.993	0.120	0.554
Dividend dummy	−0.010	0.827	0.056	0.387	−0.019	0.795
Managerial ownership	0.437	0.011	−0.150	0.598	−0.294	0.277
Year 1999 dummy	0.009	0.776	0.099	0.040	0.015	0.783
Instruments						
Pretax ROA	−0.303	0.020	0.170	0.388	0.330	0.108
Debt rating	0.219	0.000			−0.439	0.000
Undeveloped reserves	0.117	0.227			−0.613	0.000
Deferred taxes	−0.669	0.072			−0.735	0.214
Predicted high leverage dummy			0.449	0.000		
R^2	0.40		0.23		0.49	

Table A-2: Second-Stage Tobit Regressions with Residuals from First-Stage

Table A-2 shows the results of the Tobit estimation. These regressions are identical to those in Table 2, except that residuals from the first-stage estimation also included as controls. *High leverage residual* is the residual from the first-stage regression of the high leverage dummy. *Leverage residual* and *Bank ratio residual* are the corresponding residuals for the debt-to-asset and bank-to-total debt regressions, respectively.

	Model 1		Model 2	
Explanatory variables	β	p-value	β	p-value
Dependent variable: fraction of next year's production hedged				
Intercept	0.028	0.956	0.190	0.701
High leverage dummy	−0.418	0.068	−0.582	0.011
High leverage x bank debt fraction			0.632	0.004
Debt-to-assets	−1.173	0.006	1.104	0.008
Bank-to-total-debt	0.134	0.557	0.007	0.975
Log(total assets)	−0.054	0.149	−0.063	0.080
Cash-to-assets	−0.458	0.634	−0.723	0.439
Capital expenses to assets	0.576	0.003	0.635	0.001
Dividend dummy	0.086	0.172	0.047	0.448
Managerial ownership	−0.016	0.955	−0.084	0.754
Year 1999 dummy	−0.042	0.401	−0.056	0.252
High leverage residual	0.112	0.623	0.022	0.923
Leverage residual	−0.665	0.128	−0.568	0.180
Bank ratio residual	−0.122	0.611	−0.035	0.881

References

Adam, T. (2002). Why firms use non-linear hedging strategies. Working paper. Hong Kong University of Science and Technology.

Adam, T., Dasgupta, S., and Titman, S. (2004). Financing constraints, competition and hedging in industry equilibrium. Working Paper. Hong Kong University of Science and Technology, Hong Kong.

Ashbaugh, H., Collins, D. W., and LaFond, R. (2004). The effects of corporate governance on firm's credit ratings. Working paper. University of Iowa.

Baker, M., Stein, J. C., and Wurgler, J. (2002). When does the market matter? stock prices and the investment of equity-dependent firms. Working paper. Harvard Business School, Cambridge, MA.

Bartram, S. M., Brown, G. W., and Fehle, F. R. (2003). International evidence on financial derivatives usage. Working paper. Kenan-Flagler Business School, University of North Carolina at Chapel Hill, Chapel Hill, NC.

Berger, P., Ofek, E., and Yermak, D. (1997). Managerial entrenchment and capital cost structure decisions. *The Journal of Finance*, 52:1411–1438.

Berlin, M. and Loeys, J. (1988). Bond covenants and delegated monitoring. *Journal of Finance*, 43:397 – 412.

Berlin, M. and Mester, L. (1992). Debt covenants and renogiation. *Journal of Financial Intermediation*, 2:95 – 133.

Bhojraj, S. and Sengupta, P. (2004). Effect of corporate governance on bond ratings and yields: The role of instutional investors and outside directors. *Journal of Business*, forthcoming.

Bodnar, G. M., de Jong, A., and Macrae, V. (2002). The impact of instutional differences on derivatives usage: A comparative study of U.S. and Dutch firms. *European Financial Management*, forthcoming.

Breeden, D. and Viswanathan, S. (1998). Why do firms hedge? An asymmetric information model. Working paper, Fuqua School of Business, Duke University, Durham, NC.

Cantillo, M. and Wright, J. (2000). How do firms choose their lenders? An empirical investigation. *Review of Financial Studies*, 13:155 – 189.

Carey, M., Post, M., and Sharpe, S. (1997). Does corporate lending by banks and finance companies differ? *The Journal of Finance*, 53:845–878.

Carter, D. A., Rogers, D. A., and Simkins, B. J. (2004). Does fuel hedging make economic sense? The case of the us airline industry. Working paper, College of Business Administration, Oklahoma State University, Stillwater, OK.

Chava, S., Dierker, M., and Livdan, D. (2004). Do shareholder rights affect the cost of bank loans? Working paper. University of Houston, Houston, TX.

Chemmanur, T. and Fulghieri, P. (1994). Reputation, renogation, and the choice between bank loans and publicly traded debt. *Review of Financial Studies*, 7:475 – 506.

Cooper, I. A. and Mello, A. S. (1999). Corporate hedging: The relevance of contract specifications and banking relationships. *European Finance Review*, 2:195 – 223.

Cremers, M., Nair, V., and Wei, C. (2004). The impact of shareholder control on bondholders. Working paper. The Wharton School, University of Pennsylvania.

Davidson, R. and MacKinnon, J. G. (1993). *Estimation and Inference in Econometrics*. Oxford University Press.

DeMarzo, P. and Duffie, D. (1991). Corporate financial hedging with proprietary information. *Journal of Economic Theory*, 53:261 – 286.

DeMarzo, P. M. and Duffie, D. (1995). Corporate inventives for hedging and hedge accounting. *Review of Financial Studies*, 8(3):743 – 771.

Denis, D. and Mihov, V. (2003). The choice among bank debt, non-bank private debt, and public debt" Evidence from new corporate borrowings. *Journal of Financial Economics*, 70(1):3 – 28.

Diamond, D. (1991). Monitoring and reputation: The choice between bank loans and directly placed debt. *Journal of Political Economy*, pages 689 – 721.

Fehle, F. and Tsyplakov, S. (2004). Dynamic risk management: Theory and evidence. *Journal of Financial Economics*, forthcoming.

Froot, K., Scharfstein, D., and Stein, J. (1993). Risk management: Coordinating corporate investment and financing policies. *The Journal of Finance*, 48:1624 – 1658.

Geczy, C., Minton, B. A., and Schrand, C. (1997). Why firms use currency derivatives. *The Journal of Finance*, LII(4):1323 – 1354.

Graham, J. R., Michael L. Lemmon, and James S. Schallheim (1998). Debt, lease, taxes and the endogeneity of corporate tax status. *The Journal of Finance*, 53:131 – 162.

Graham, J. R. and Rogers, D. A. (2002). Do firms hedge in response to tax incentives? *The Journal of Finance*, LVII:815 – 839.

Haushalter, D. (2000). Financing policy, basis risk, and corporate hedging: Evidence from oil and gas producers. *The Journal of Finance*, LV(1):107 – 152.

Houston, J. and James, C. (1996). Bank information monopolies and the mix of private and public debt claims. *Journal of Finance*, 51:1863–89.

James, C. (1987). Some evidence on the uniqueness of bank loans. *Journal of Financial Economics*, 19:217–235.

James, C. and Smith, D. C. (2000). Are banks still special? New evidence on their role in capital-raising processes. *Journal of Applied Corporate Finance*, 13:52–63.

Jensen, M. C. and Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3:305–360.

Johnson, S. A. (1997). An empirical analysis of the determinants of corporate debt ownership structure. *The Journal of Financial and Quantitative Analysis*, 32(1):47–69.

Kang, J., Shivdasani, A., and Yamada, T. (2000). The effect of bank relations on investment decisions: An investigation of Japanese takeover bids. *The Journal of Finance*, LV(5):2197–2218.

Knopf, J., Nam, J., and Jr., J. T. (2000). The volatility and price sensitivities of managerial stock option portfolios and corporate hedging. *The Journal of Finance*, 57(2):801 – 813.

Krishnaswami, S., Spindt, P. A., and Subramaniam, V. (1999). Information asymmetry, monitoring and the placement structure of corporate debt. *Journal of Financial Economics*, 51:407–434.

Lel, U. (2003). Currency risk management, corporate governance, and financial market development. Working Paper. Kelley School of Business, Indiana University, Bloomington, IN.

Leland, H. E. (1998). Agency costs, risk management and capital structure. *The Journal of Finance*, 53:1213 – 1243.

Lookman, A. A. (2004). Does hedging increase firm value? Evidence from oil and gas producers. Working paper. Carnegie Mellon University.

Lummer, S. and McConnell, J. J. (1989). Further evidence on the bank lending process and the capital market response to bank loan agreements. *Journal of Financial Economics*, 25:99–122.

Maddala, G. (1983). *Limited Dependent and Qualitative Variables in Econometrics*. Econometrics Society Monographs, Cambridge University Press.

Mello, A. S. and Parsons, J. E. (2000). Hedging and liquidity. *The Review of Financial Studies*, 13(1):127 – 153.

Nain, A. (2004). The strategic motives for corporate risk management. Working Paper. University of Michigan.

Purnanandam, A. (2003). Financial distress and corporate risk management: Theory and evidence. Working Paper. Cornell University, Ithaca, NY.

Rajan, R. G. (1992). Insiders and outsiders: The choice between informed and arm's length debt. *The Journal of Finance*, 50:1113–1146.

Ross, M. P. (1997). Corporate hedging: What, why and how? Working paper. University of California, Berkeley.

Smith, C. and Stulz, R. (1985). The determinants of a firm's hedging policies. *Journal of Financial and Quantitative Analysis*, 20:391–405.

Smith, C. W. and Warner, J. (1979). On financial contracting: An analysis of bind covenants. *Journal of Financial Economics*, 7:117–161.

Stulz, R. M. (1996). Rethinking risk management. *Journal of Applied Corporate Finance*, 9:8 – 24.

Tufano, P. (1996). Who manages risk? An empirical examination of risk management practices in the gold mining industry. *The Journal of Finance*, LI(4):1097 – 1137.

Tufano, P. (1998). Agency costs of corporate risk management. *Financial Management*, 27:67–77.

White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a test for heteroskedasticity. *Econometrica*, 48:817 – 838.

Table 1: Summary Statistics

Production hedged is the fraction of next year's production hedged against low commodity prices. *Total Assets* is the book value of the firm in millions of dollars. *Debt-to-assets* is book value of long-term debt, scaled by total assets. *Cash-to-assets* is the cash and cash equivalents held by the firm, scaled by total assets. *Capital expenses to assets* is the capital expenditure scaled by sales. *Undeveloped reserves* is the ratio of proven undeveloped reserves scaled by total proven reserves. *Intangibles-to-assets* is the intangibles scaled by total assets. *Dividend dummy* equals one if the firm issues common dividends. *KZ index* is the modified Kaplan-Zingales index, calculated according to Baker et al. (2002). *Pretax ROA* is the earnings before extraordinary items scaled by total assets. *Inside ownership* is fraction of common shares held by managers. *Bank-to-total-debt* is the fraction of the total long-term debt held by a bank. For firm-years with no long-term debt, this ratio is set to zero.

Variable	N	Mean	Std Dev	5th %ile	Median	95th %ile
Production hedged	146	0.297	0.253	0.000	0.245	0.760
Total assets	146	1031	1833	55	322	5503
Debt-to-assets	146	0.372	0.230	0.000	0.362	0.760
Cash-to-assets	146	0.050	0.062	0.002	0.025	0.187
Capital expenses to assets	146	0.216	0.131	0.052	0.196	0.453
Undeveloped reserves	146	0.295	0.180	0.043	0.255	0.651
Dividend dummy	146	0.185	0.390	0.000	0.000	1.000
KZ index	146	1.054	1.491	-0.561	0.985	2.951
Pretax ROA	146	0.033	0.131	-0.128	0.039	0.173
Managerial ownership	146	0.062	0.106	0.000	0.014	0.370
Bank-to-total-debt	146	0.497	0.406	0.000	0.489	1.000

Table 2: Effect of Bank Debt on Hedging

Table 2 shows results of the pooled Tobit regression of the fraction of next year's production hedged. *Model 1* contains the typical explanatory variables considered in the literature. *High leverage dummy* equals unity if the debt-to-asset ratio is greater than the 90th percentile value and zero otherwise. See Table 1 for a description of the independent variables. *Model 2* also includes an interaction term. *High leverage* $\times$ *bank debt* is the interaction of the high leverage dummy and the bank-to-total-debt ratio. The definition of the other control variables is provided in Table 1. The coefficients for the intercept and time dummy are not shown to conserve space. $Pseudo-R^2$ is calculated by regressing the actual fraction of production hedged on the estimated value from the Tobit model. The regression coefficients are reported as marginal effects.

	Model 1		Model 2	
Explanatory variables	Slope	p-value	Slope	p-value
Dependent variable: fraction of next year's production hedged				
High leverage dummy	**-0.203**	**0.012**	**-0.410**	**0.000**
High leverage x bank ratio			**0.519**	**0.006**
Debt-to-assets	0.479	0.000	0.524	0.000
Log(total assets)	-0.054	0.003	-0.056	0.002
Cash-to-assets	-0.920	0.020	-0.986	0.012
Capital expenses to assets	0.326	0.030	0.390	0.009
Dividend dummy	0.048	0.364	0.024	0.655
Managerial ownership	0.202	0.287	0.179	0.337
Bank-to-total-debt	-0.011	0.837	-0.045	0.228
Number of Observations	146		146	
Censored Values	22		22	
Log Likelihood	-28.0		-24.4	
Pseudo-R^2	0.217		0.258	

Table 3: Robustness Check - Alternate Definitions of High Leverage

Table 3 shows how the coefficients of the high leverage measure, its interaction with the bank debt fraction and leverage change when different proxies are used for high leverage. Panel A uses the high leverage dummy, and reproduces the results from Table 2. Panel B uses a 'hockey stick' function, while Panel C uses the squared value of debt-to-assets, as suggested by Purnanandam (2003). Besides the change in high leverage proxy, the models estimated in Panels B and C are identical to that shown in Table 2. Only the leverage and high leverage terms are reported; other coefficients are not shown to conserve space.

	Model 1		Model 2	
Explanatory variables	Slope	p-value	Slope	p-value
Dependent variable: fraction of next year's production hedged				
Panel A: High Leverage Proxy = $I_{D/A \geq X}$, *X = 90th %ile value*				
High leverage dummy	-0.203	0.012	-0.410	0.000
High leverage x bank ratio			0.519	0.006
Debt-to-assets	0.479	0.000	0.524	0.000
Panel B: High Leverage Proxy = $max[0, D/A - X]$, *X = 90th %ile value*				
$max[0, D/A - X]$	-1.289	0.000	-1.820	0.000
$max[0, D/A - X]$ x bank ratio			4.815	0.020
Debt-to-assets	0.506	0.000	0.479	0.000
Panel C: High Leverage Proxy = $(D/A)^2$				
$(D/A)^2$	-0.669	0.012	-0.631	0.017
$(D/A)^2$ x bank ratio			0.545	0.076
Debt-to-assets	0.868	0.000	0.692	0.007

Table 4: Change Regression

Table 4 shows results of estimating an OLS model of change in the fraction of production hedged against changes in the set of explanatory and control variables considered earlier. The model estimated is of the form:

$$\Delta H = \beta_L * \Delta L + \beta_{HL} * \Delta HL + \beta_{HLR} * \Delta HL * R + \beta_{X'} * \Delta X' + \varepsilon$$

where, for any variable *Z*, ΔZ_i is defined as $Z_{i,t} - Z_{i,t-1}$, *H* is the fraction of production hedged, *L* is the leverage variable with the debt-to-asset ratio used as its proxy, *HL* is the high leverage dummy, *R* is the bank debt ratio, and *X'* is the set of control variables used. See Table 2 for a description of the explanatory and control variables. The p-values are corrected for heteroscedasticity using White (1980) standard errors.

Explanatory variables	Slope	p-value
Intercept	0.329	0.022
HL	-0.263	0.092
$HL * R$	0.516	0.034
Debt-to-assets	0.428	0.048
Log(total assets)	-0.051	0.004
Cash-to-assets	0.184	0.084
Capital expenses-to-assets	-2.005	0.000
N	69	
R^2	0.366	

Table 5: Investigation for Reverse Causality

Table 5 shows results of estimating an OLS model of the level of bank debt on the contemporaneous and lagged hedging variable. The model estimated is of the form:

$$B_t = \beta_1 * H_t + \beta_2 * H_{t-1} + \beta_3 * B_{t-1} + \beta_W * W_t + \varepsilon$$

where B_t is the contemporaneous bank debt, normalized by total assets, H_t and H_{t-1} are the contemporaneous and lagged fraction of production hedged, and W is a set of explanatory variables considered in the literature to explain a firm's level of bank debt. The explanatory variables include all exogenous and instrumental variables used earlier for the Hausman test which were significant in explaining either the level or the source of debt. See Appendix A for further details. The p-values are corrected for heteroscedasticity using White (1980) standard errors.

Explanatory variables	Slope	p-value
Dependent variable: Level of bank debt		
Intercept	-0.011	0.883
Production hedged	0.175	0.003
Lagged production hedged	-0.008	0.893
Lagged bank debt	0.588	0.000
Log(total assets)	0.001	0.922
Cash-to-assets	-0.150	0.460
Capital expenses to assets	0.133	0.238
Managerial ownership	-0.030	0.757
Deferred taxes	-0.047	0.767
Pretax ROA	-0.035	0.344
Debt rating	-0.072	0.002
Undeveloped reserves	0.040	0.542
N	69	
R^2	0.774	

Table 6: Effect of Debt Rating and Firm Size on Hedging

Table 6 shows results of estimating a model of the form:

$$\begin{aligned} production\ hedged\ =&\beta_L * L\ +\beta_{HL} * HL\ +\beta_{HLR} * HL * R+ \\ &\beta_{HL-unrated} * HL * I_{unrated} + \beta_{HL-size} * HL * SIZE+ \\ &\beta_X * X + \varepsilon \end{aligned}$$

HL is the high leverage dummy, I_{rated} is a dummy variable that equals unity if the firm is unrated and $SIZE$ is the proxy for firm size, namely, the log of the total assets of the firm. See Table 2 for an explanation of the other variables. Coefficients for the intercept and time dummy are not shown to conserve space. $Pseudo-R^2$ is calculated by regressing the actual fraction of production hedged on the estimated value from the Tobit model. The regression coefficients are reported as marginal effects. The interaction terms, $HL*R$, $HL*I_{rated}$ and $HL*SIZE$ are first projected on HL and the residual is then used for estimating the model to work around the problem of correlated regressors.

Explanatory variables	Slope	p-value
Dependent variable: fraction of next year's production hedged		
HL	-0.228	0.004
$HL*R$	0.574	0.068
$HL*I_{unrated}$	0.065	0.828
$HL*SIZE$	-0.012	0.908
Debt-to-assets	0.524	0.000
Log(total assets)	-0.056	0.002
Cash-to-assets	-0.988	0.012
Capital expenses to assets	0.390	0.009
Dividend dummy	0.023	0.662
Managerial ownership	0.189	0.325
Bank-to-total-debt	-0.031	0.583
Number of Observations	146	
Censored Values	22.00	
Log Likelihood	-24.33	
Pseudo-R^2	0.258	

Table 7: Effect of Insider Ownership on Hedging

Table 2 shows results of the pooled Tobit regression of the fraction of next year's production hedged. *Model 1* contains the typical explanatory variables considered in the literature alongwith an interaction term for the high leverage dummy and insider ownership, which is defined as the fraction of common shares held by insiders. *High leverage dummy* equals unity if the debt-to-asset ratio is greater than the 90th percentile value and zero otherwise. *Model 2* also includes *High leverage* $\times$ *bank debt*, which is the interaction of the high leverage dummy and the bank-to-total-debt ratio. The definition of the other control variables is provided in Table 1. The coefficients for the intercept and time dummy are not shown to conserve space. $Pseudo - R^2$ is calculated by regressing the actual fraction of production hedged on the estimated value from the Tobit model. The regression coefficients are reported as marginal effects.

	Model 1		Model 2	
Explanatory variables	Slope	*p*-value	Slope	*p*-value
Dependent variable: fraction of next year's production hedged				
High leverage dummy	-0.291	0.003	-0.546	0.000
High leverage $\times$ bank ratio			0.581	0.002
High leverage $\times$ managerial ownership	0.825	0.100	1.041	0.037
Debt-to-assets	0.483	0.000	0.532	0.000
Log(total assets)	-0.053	0.003	-0.055	0.002
Cash-to-assets	-0.847	0.032	-0.902	0.020
Capital expenses to assets	0.306	0.041	0.372	0.012
Dividend dummy	0.052	0.324	0.026	0.624
Managerial ownership	0.067	0.744	0.009	0.963
Bank-to-total-debt	0.010	0.861	-0.037	0.496
Number of Observations	146		146	
Censored Values	22		22	
Log Likelihood	-26.7		-22.2	
Pseudo-R^2	0.230		0.279	

Figure 1: Variation in Modeled Hedging Policy with Source of Debt

Figure 1 plots the variation in the fraction of production hedged with leverage for different sources of debt. The plot labelled *pooled* is based on a model that only includes the squared value of debt-to-assets as the proxy for high leverage. The plots labelled *bank debt* and *non-bank debt* are based on a model that also includes the interaction term of the squared value of debt-to-assets with the bank ratio variable. For all plots, the Y-axis is the fraction of next year's production hedged against a fall in commodity prices. The X-axis is the ratio of total debt-to-assets, bank debt-to-assets and the non-bank debt-to-assets for the *pooled*, *bank debt* and *non-bank debt* plots, respectively. See the text for additional details of how the plots are generated.